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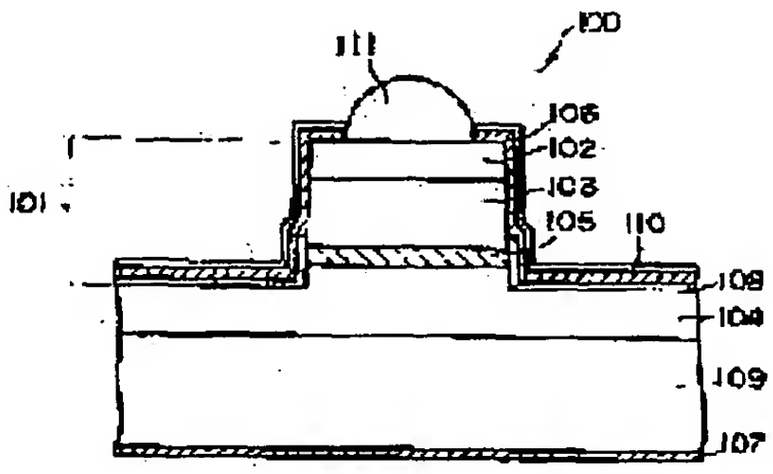
(54) SURFACE LIGHT EMISSION TYPE SEMICONDUCTOR LASER AND ITS PRODUCTION

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a surface light emission type semiconductor laser which makes it possible to set the radiation angle of a laser beam small even if the laser output is increased.
SOLUTION: The surface light emission type semiconductor laser 100 has a resonator in the perpendicular direction on a semiconductor substrate and emits the laser beam in a direction perpendicular to the semiconductor substrate from this resonator. An exit part 111 having a convex l ns shape is formed on the surface of a semiconductor deposit (columnar part) 101 including the resonator. This surface light emission type semiconductor laser 100 is produced by a production process including the following stages: (a) the columnar part 101 is formed on the semiconductor substrate; (b) an electrode (upper electrode) 106 for injecting current to the resonator is formed in the state of exposing the prescribed region of the surface of the columnar part 101; (c) the surface of the upper electrode 106 is subjected to a liquid repelling treatment; (d) the exit part 111 is constituted when cured and the liquid material repelled by the liquid repelling film is located on the surface of the exposed columnar part 101 and (e) the exit part 111 is formed by curing the liquid material.



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CLAIMS

[Claim(s)]
[Claim 1] Field luminescence type semiconductor laser in which the outgoing radiation section which has a vertical resonator on a semiconductor substrate and has a convex lens configuration on the front face of the semiconductor deposition object which is the field luminescence type semiconductor laser which carries out outgoing radiation of the laser beam in the direction perpendicular to the aforementioned semiconductor substrate from the aforementioned resonator, and contains the aforementioned resonator is formed.
[Claim 2] Field luminescence type semiconductor laser by which the electrode for pouring current into the aforementioned resonator in a claim 1 so that the aforementioned outgoing radiation section may be surrounded is formed in the front face of the aforementioned semiconductor deposition object.
[Claim 3] Field luminescence type semiconductor laser by which ****** is formed in the front face of the aforementioned electrode in the claim 2.
[Claim 4] It is the field luminescence type semiconductor laser which the quality of the material of the aforementioned outgoing radiation section becomes from a high molecular compound in either a claim 1 or the claim 3.
[Claim 5] The manufacture method of the field luminescence type semiconductor laser containing following process (a) - (e).
(a) After the predetermined field of the front face of a process and the (b) aforementioned semiconductor deposition object which forms the semiconductor deposition object which deposits two or more semiconductor layers on a semiconductor substrate, and contains a resonator has been exposed On the front face of the process which forms the electrode for pouring current into the aforementioned resonator, and the (c) aforementioned electrode The process which is made to harden the process located in the front face of the semiconductor deposition object which exposed the liquefied object which constitutes the outgoing radiation section which has a convex lens configuration if the process which performs **** processing, and (d) hardening are carried out, and is crawled by the aforementioned ******, and the (e) aforementioned liquefied object, and forms the aforementioned outgoing radiation section.
[Claim 6] When the aforementioned process (c) forms ****** in the front face of the aforementioned electrode in a claim 5, it is the manufacture method of the field luminescence type semiconductor laser which performs **** processing and which is a process.
[Claim 7] It is the manufacture method of the field luminescence type semiconductor laser which the aforementioned process (d) makes [semiconductor laser] the drop of the aforementioned liquefied object at the nose of cam of a dispenser nozzle in a claim 5, contacts this drop on the front face of the semiconductor deposition object which carried out [aforementioned] exposure at least, and locates this liquefied object in this front face and which is a process.
[Claim 8] It is the manufacture method of the field luminescence type semiconductor laser which it injects [semiconductor laser] on the front face of the semiconductor deposition object with which the aforementioned process (d) carried out [aforementioned] exposure of the aforementioned liquefied object in the claim 5 using the ink-jet head, and locates this liquefied object in this front face and which is a process.
[Claim 9] It is the manufacture method of the field luminescence type semiconductor laser which is a liquefied object that the aforementioned liquefied object contains the precursor of a resin or a resin in either a claim 5 or the claim 8.
[Claim 10] It is the manufacture method of the field luminescence type semiconductor laser which is the monomolecular film which consists of a compound with which the aforementioned ****** sticks to the aforementioned electrode in either a claim 5 or the claim 9.
[Claim 11] It is the manufacture method of field luminescence type semiconductor laser that the aforementioned electrode consists of a gold layer in either a claim 5 or the claim 10.
[Claim 12] It is the manufacture method of field luminescence type semiconductor laser which consists of a thiol containing the atomic group which has the property in which the aforementioned monomolecular film crawls the

aforementioned liquefied object at one end in a claim 10.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the field luminescence type semiconductor laser which carries out outgoing radiation of the laser beam perpendicularly to a semiconductor substrate, and its manufacture method.
[0002]
Background of the Invention] Field luminescence type semiconductor laser has the feature with an isotropic and laser radiation angle of being small, compared with end-face laser. When field luminescence type semiconductor laser is applied to the optical fiber of a large core diameter, for example, a plastic optical fiber, incidence of the laser beam can be directly carried out efficiently into a fiber without a lens etc. because of the above-mentioned feature. Therefore, the optical-communication module of very easy composition is realizable by combining a plastic optical fiber and field luminescence type semiconductor laser.
[0003]
[Problem(s) to be Solved by the Invention] However, since there is a fault that a transfer loss is large, in order to lengthen a transmission distance, the light source of a big optical output is needed for a plastic optical fiber. In order to increase the laser output of a surface emission-type laser, it is effective to enlarge laser outgoing radiation aperture. However, if laser outgoing radiation aperture is enlarged, the problem that a radiation angle becomes large will arise. A result which causes directly the fall of the quantity of light of the laser beam in which increase of a radiation angle carries out incidence to joint efficiency, i.e., fiber incore, reduction of an installation margin, etc. when incidence is performed for a laser beam to an optical fiber is brought for simplification of the composition of an optical transmitting module, without minding a lens between direct coupling, i.e., an optical fiber, and the light source. Therefore, there was a problem that coexistence of simplification of securing the length of a transmission distance and the composition of the optical transmitting module by direct coupling was difficult.
[0004] The purpose of this invention is to offer the field luminescence type semiconductor laser which makes it possible to set up the radiation angle of a laser beam small though the above-mentioned coexistence is achieved and a laser output is specifically increased, and its manufacture method.
[0005]
[Means for Solving the Problem] The field luminescence type semiconductor laser of this invention has a vertical resonator on a semiconductor substrate, it is the field luminescence type semiconductor laser which carries out outgoing radiation of the laser beam in the direction perpendicular to the aforementioned semiconductor substrate from the aforementioned resonator, and the outgoing radiation section which has a convex lens configuration is formed in the front face of the semiconductor deposition object containing the aforementioned resonator.
[0006] According to this field luminescence type semiconductor laser (henceforth a "surface emission-type laser"), in a laser outgoing radiation side, a laser beam can be made refracted and the radiation angle can be narrowed by having formed in the front face of the semiconductor deposition object containing an above-mentioned resonator the outgoing radiation section which has the aforementioned convex lens configuration. Moreover, it also becomes possible to set up a radiation angle small, though according to this composition laser outgoing radiation aperture is enlarged since a radiation angle can be narrowed in a laser outgoing radiation side, and a laser output is increased.
[0007] The quality of the material of the aforementioned outgoing radiation section can mention a high molecular compound. Specifically, at least one sort chosen from the group of polyimide resin, ultraviolet-rays hardening type acrylic resin, and an ultraviolet-rays hardening type epoxy resin can be mentioned.
[0008] The electrode for pouring current into the aforementioned resonator is formed in the front face of the aforementioned semiconductor deposition object. As this outgoing radiation section is surrounded, the aforementioned

electrode is formed so that the aforementioned outgoing radiation section may not be covered. Furthermore, on the surface of an electrode, it is desirable to form ******.

[0009] The surface emission-type laser concerning this invention can be formed by the manufacture method containing following process (a) - (e).

[0010] (a) After the predetermined field of the front face of a process and the (b) aforementioned semiconductor deposition object which forms the semiconductor deposition object which deposits two or more semiconductor layers on a semiconductor substrate, and contains a resonator has been exposed On the front face of the process which forms the electrode for pouring current into the aforementioned resonator, and the (c) aforementioned electrode The process which is made to harden the process located in the front face of the semiconductor deposition object which exposed the liquefied object which constitutes the outgoing radiation section which has a convex lens configuration if the process which performs **** processing, and (d) hardening are carried out, and is crawled by the aforementioned ******, and the (e) aforementioned liquefied object, and forms the aforementioned outgoing radiation section.

[0011] Thus, **** processing can be performed for the front face of an electrode, the position in which it is going to prepare the outgoing radiation section to which the electrode has carried out opening of the liquefied object can be supplied, and the laser outgoing radiation section which functions as a micro lens only by hardening the liquefied object which remained on the contact layer of the upper surface of the pillar-shaped section can be formed by the self aryne. That is, it condenses only by leaving it, even if a liquefied object does not add a hand in the position in which it is going to prepare the outgoing radiation section spontaneously by giving a difference to the grade of the wetting to the liquefied object of the front face of an electrode, and the front face of the exposed semiconductor deposition object. Consequently, the outgoing radiation section can be formed by the self aryne. Thus, since the laser outgoing radiation section can be formed by the self aryne, optical-axis doubling is unnecessary and the laser outgoing radiation section without an optical-axis gap can be formed at a very easy process.

[0012] the **** processing 4 by forming ****** as **** processing in the aforementioned process (c), for example, for example, CF, etc. -- fluorine-ization of the front face using the plasma of fluorine system gas etc. can be mentioned Among these, the **** processing by forming ****** is desirable.

[0013] In the aforementioned process (d), the following two methods can be mentioned, for example as a means to supply a liquefied object to the front face of the semiconductor deposition object which the **** exposed.

[0014] (1) It is the method of 1st making the drop of the aforementioned liquefied object at the nose of cam of a dispenser nozzle (henceforth a "nozzle"), contacting this drop on the front face of the semiconductor deposition object which the **** exposed at least, and supplying this liquefied object to this front face.

[0015] Thus, the amount of drops at the viscosity of a liquefied object, the diameter of a nozzle, and the nose of cam of a nozzle etc. can be adjusted, or the thickness of the outgoing radiation section can be easily controlled by using a nozzle with the surface treatment at the nose of cam of a nozzle etc. Moreover, since the supply method of the liquefied object by the nozzle cannot be easily influenced by the viscosity of a liquefied object, its range of an usable liquefied object is wide. Furthermore, since only a required place can supply a liquefied object certainly, there is no futility and a liquefied object does not adhere at an excessive place.

[0016] (2) It is the method of injecting on the front face of the semiconductor deposition object which used the ink-jet head for the 2nd, and the **** [the aforementioned liquefied object] exposed, and supplying this liquefied object to this front face.

[0017] The method using the ink-jet head can supply a liquefied object to the aforementioned front face in a short time, and has the advantage that productivity is high.

[0018] As for the aforementioned liquefied object, it is desirable to include the precursor of a high molecular compound or a high molecular compound.

[0019] If it is the film which has the property which crawls the aforementioned liquefied object as the aforementioned ******, although it will not be limited especially, the monomolecular film which consists of a compound which sticks to the aforementioned electrode, for example can be mentioned.

[0020] When the front face of the aforementioned electrode consists of a gold layer, the aforementioned monomolecular film has the thiol which contains in one end the atomic group (henceforth a "functional group") which has the property which crawls the aforementioned liquefied object to a desirable bird clapper. Below, this desirable reason is explained.

[0021] A thiol has the property chemisorbed into gold, when the sulfur atom of the sulfhydryl group of a thiol and the golden atom of a golden front face carry out a chemical bond in covalent bond. If it floods with the solution containing the thiol which has a functional group for the aforementioned electrode which consists of a gold layer for this property, the thiol which has a functional group at the end will take the orientation which turned the sulfhydryl group to the aforementioned electrode, and will chemisorb it on the front face of the aforementioned electrode. On the other hand,

in the front face of the exposed semiconductor deposition object, the thiol which has a functional group at the end is not chemisorbed. Therefore, ****** can be formed in the front face of the aforementioned electrode that it is simple and alternatively by making into ****** the monomolecular film which consists of a thiol containing a functional group.
[0022]
[Embodiments of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained, referring to a drawing.
[0023] (Form of the 1st operation)
(Structure of a device) Drawing 1 is the cross section showing typically the surface emission-type laser concerning the form of operation of the 1st of this invention.
[0024] The distribution reflection type multilayer mirror of 25 pairs to which the surface emission-type laser 100 shown in drawing 1 carried out the laminating of aluminum0.15Ga0.85As and the AlAs by turns on the n type GaAs substrate 109 (Hereafter) it is called a "lower DBR mirror" -- GaAs with a 104 and a thickness of 3nm -- a well -- from a layer and an aluminum0.3Ga0.7As barrier layer with a thickness of 3nm -- changing -- this -- a well -- a layer the quantum well barrier layer 105 which consists of three layers, aluminum0.15Ga0.85As, and aluminum0.9Ga0.1As The laminating of the distribution reflection type multilayer mirror (henceforth an "up DBR mirror") 103 and the contact layer 102 of 30 pairs which carried out the laminating by turns is carried out one by one, and they are formed.
[0025] The up DBR mirror 103 is used as p type by doping Zn, and let the lower DBR mirror 104 be n type by doping Se. Therefore, a pin diode is formed by the quantum well barrier layer 105 and the lower DBR mirror 104 by which the up DBR mirror 103 and the impurity are not doped.
[0026] The contact layer 102 has the property which does not crawl the liquefied object mentioned later. Moreover, the contact layer 102 needs behind to be the quality of the material in which the up electrode 106 of a publication and ohmic contact are possible, and consists of aluminum0.15Ga0.85As by which it was doped in the case of AlGaAs system material (for example, three or more [1019cm -] high-concentration impurities).
[0027] The pillar-shaped section 101 is formed by **********ing in the shape of a mesa except for a predetermined field to the middle of the contact layer 102, the up DBR mirror 103, the quantum well barrier layer 105, and the lower DBR mirror 104. Moreover, on the pillar-shaped section 101, the outgoing radiation section 111 of a laser beam is formed.
[0028] Furthermore, the side of the pillar-shaped section 101 reaches in part, and as an insulating layer 108 is wearing the upper surface of the lower DBR mirror 104, it is formed.
[0029] And it consists of a metal layer which carried out the laminating of the metal layer which carried out the laminating of titanium, platinum, and the gold one by one or chromium, a golden-zinc alloy, and the gold one by one, and on the upper surface of the pillar-shaped section 101, as it contacts the contact layer 102 and in the shape of a ring and the up electrode 106 is wearing a part of side of the exposed pillar-shaped section 101, and front face of an insulating layer 108, it is formed. ****** 110 is formed on the up electrode 106. ****** 110 is explained in full detail in the place of the manufacture process mentioned later.
[0030] Moreover, the Au-germanium alloy and the lower electrode 107 which carried out the laminating of nickel and the Au one by one are formed in the bottom of the n type GaAs substrate 109.
[0031] Furthermore, on the pillar-shaped section 101, the outgoing radiation section 111 is surrounded by the up electrode 106, and is made and prepared. The upper surface of the outgoing radiation section 111 constitutes a convex lens side, and the function to make a laser beam refracted is given. Although especially the quality of the material of the outgoing radiation section is not limited, polyimide resin, ultraviolet-rays hardening type acrylic resin, an ultraviolet-rays hardening type epoxy resin, etc. are mentioned, and it can mention polyimide resin preferably, for example.
[0032] Below, operation of a surface emission-type laser 100 is explained.
[0033] In the up electrode 106 and the lower electrode 107, if the voltage of the forward direction is impressed to a pin diode, in the quantum well barrier layer 105, the reunion of an electron and an electron hole will happen and recombination radiation will arise. Then, in case the produced light goes back and forth between the up DBR mirror 103 and the lower DBR mirrors 104, induced emission happens and luminous intensity is amplified. If optical gain turns around optical loss a top, laser oscillation will happen and outgoing radiation of the laser beam will be perpendicularly carried out from the outgoing radiation section 111 to a substrate.
[0034] In the form of this operation, the outgoing radiation section 111 is formed on the pillar-shaped section 101, and a characteristic thing is formed in a convex lens configuration, the upper surface, i.e., the laser outgoing radiation side, of the outgoing radiation section 111, further, as shown in drawing 1 . By forming the laser outgoing radiation side in the convex lens configuration, in a laser outgoing radiation side, a laser beam can be made refracted and the radiation

angle can be narrowed. Moreover, it also becomes possible to set up a radiation angle small, though laser outgoing radiation aperture is enlarged according to this composition, since a radiation angle is controllable in a laser outgoing radiation side.

[0035] (Manufacture process of a device) Next, the manufacture process of a surface emission-type laser 100 shown in drawing 1 is explained. Drawing 2 - drawing 6 show the manufacturing process of a surface emission-type laser 100.

[0036] (1) Explain first, referring to drawing 2 . On the n type GaAs substrate 109, the laminating of aluminum0.15Ga0.85As and the AlAs is carried out by turns, and the lower DBR mirror 104 of 25 pairs which doped Se is formed. next, the lower DBR mirror 104 top -- GaAs with a thickness of 3nm -- a well -- from a layer and an aluminum0.3Ga0.7As barrier layer with a thickness of 3nm -- changing -- this -- a well -- a layer forms the quantum well barrier layer 105 which consists of three layers Furthermore, on the quantum well barrier layer 105, the laminating of aluminum0.15Ga0.85As and the aluminum0.9Ga0.1As is carried out by turns, and the up DBR mirror 103 of 30 pairs which doped Zn is formed. Then, the laminating of the contact layer 102 which consists of aluminum0.15Ga0.85As on the up DBR mirror 103 is carried out.

[0037] Above-mentioned each class can be grown epitaxially by the organic-metal vapor-growth (MOVPE:Metal-OrganicVapor Phase Epitaxy) method. 750 degrees C and a growth pressure are 2x104Pa, at this time, for example, growth temperature, the organic metal of TMGa (trimethylgallium) and TMAl (trimethylaluminum) can be used for an III group raw material, and it can use DEZn (dimethyl zinc) for V group raw material at H2Se and p type dopant at AsH3 and n type dopant.

[0038] Next, on the contact layer 102, after applying a photoresist, as shown in drawing 2 , the 1st resist layer R1 of a predetermined pattern is formed by carrying out patterning of the photoresist, by photo lithography.

[0039] (2) Subsequently, as shown in drawing 3 , by using the 1st resist layer R1 as a mask, to the middle of the contact layer 102, the up DBR mirror 103, the quantum well barrier layer 105, and the lower DBR mirror 104, ********** in the shape of a mesa and form the pillar-shaped section 101 by the reactive-ion-etching method. The reactant ion-beam-etching method for having used chlorine or chlorine-based gas (a hydrogen chloride, BCl3) as etching gas is usually used for this etching.

[0040] (3) Subsequently, as shown in drawing 4 , form the silicon oxide (SiOX film) of 100-300nm of thickness on a substrate using SiH4 (mono silane) gas and O2 (oxygen) gas by the ordinary-pressure heat CVD which makes N2 (nitrogen) gas carrier gas. Then, by the photolithography and dry etching, as shown in drawing 4 , the side of the pillar-shaped section 101 reaches in part, except for a part of lower DBR mirror 104, etching removal of the silicon oxide is carried out, and an insulating layer 108 is formed.

[0041] Subsequently, a Au-germanium alloy and the lower electrode 107 which carried out the laminating of nickel and the Au one by one are formed in the inferior surface of tongue of a substrate 109 by the vacuum deposition method.

[0042] Furthermore, as shown in drawing 4 , the up electrode 106 is formed by the lift-off method so that it may contact the contact layer 102 and in the shape of a ring on the upper surface of the pillar-shaped section 101 and the side and the insulating layer 108 of the pillar-shaped section 101 may be covered. Here, the metal layer which carried out the laminating of titanium, platinum, and the gold one by one was used for the up electrode 106.

[0043] (4) Next, as shown in drawing 4 , form ****** 110 on the up electrode 106.

[0044] ****** 110 has the property which crawls the liquefied object mentioned later.

[0045] Here, when the front face of the metal layer which constitutes the up electrode 106 is a gold layer, it consists of a monomolecular film obtained as follows as ****** 110, for example.

[0046] The thiol which has a functional group at the end is dissolved in the ethanol solution of 1-10mM. If the up electrode 106 is flooded with the solution, the monomolecular film (henceforth a "thiol monomolecular film") of the thiol 112 which has a functional group will be formed only on the up electrode 106.

[0047] The thiol which has at the end the functional group of the fluorine system expressed with CF3(CF2) n(CH2) mSH (m shows the integer of 5-60 and n shows the integer of 1-20) as a thiol which has a functional group at the end here, for example can be mentioned.

[0048] Why the thiol monomolecular film 116 is formed on the up electrode 106 with reference to drawing 5 below is explained.

[0049] Drawing 5 is the enlarged view having shown typically a part of upper surface of the pillar-shaped section 101 immediately after forming a thiol monomolecular film.

[0050] A thiol has the property chemisorbed into gold, when the sulfur atom and golden atom of a sulfhydryl group of a thiol carry out a chemical bond in covalent bond. If it floods with the solution containing the thiol which has a functional group for the up electrode 106 which consists of a gold layer 115 for this property, as shown in drawing 5 , the thiol 112 which has a functional group at the end will take the orientation which turned the sulfhydryl group 113 to

the up electrode 106, and will chemisorb it on the front face of the up electrode 106. On the other hand, in the front face which the contact layer 102 of the upper surface of the pillar-shaped section 101 exposed, the thiol which has a functional group at the end is not chemisorbed. Moreover, the functional group 114 which exists in the end appears in the front face of the thiol monomolecular film 116. Consequently, the thiol monomolecular film 116 can be formed on the up electrode 106.
[0051] This thiol monomolecular film acts as ****** 110 by the following reasons.
[0052] In the front face of this thiol monomolecular film 116, as shown in drawing 5 , the functional group to which the property which crawls the liquefied object mentioned later was given has appeared. For this reason, the thiol monomolecular film 116 has the property which crawls the liquefied object mentioned later, and can act as ****** 110.
[0053] Thus, the advantage which forms ****** 110 using chemical absorption is in the point which can form ****** 110 alternatively and simple on the up electrode 106.
[0054] (5) Next, supply a liquefied object to the pillar-shaped section 101 upper surface by the nozzle.
[0055] This supplying method is explained referring to drawing 6 . Drawing 6 is the ** type view which expressed how to supply a liquefied object to the pillar-shaped section 101 upper surface by the nozzle with time.
[0056] The liquefied object of the resin used as the quality of a component of the laser outgoing radiation section or the precursor of the resin is injected into a nozzle 117. At the nose of cam of a nozzle 117, as shown in drawing 6 (a), the drop of this liquefied object is made. Next, as shown in drawing 6 (b), this drop is contacted on the upper surface of the pillar-shaped section 101. Then, after moving a drop to the upper surface of the pillar-shaped section 101, especially the exposed surface of the contact layer 102, a nozzle 117 is detached as shown in drawing 6 (c).
[0057] The contact layer 102 consists of the quality of the material which does not crawl a liquefied object. Therefore, the liquefied object moved on the exposed contact layer 102 can be stabilized, and can exist. Moreover, the liquefied object which disturbed is crawled on the up electrode 106 by ****** 110 formed on the up electrode 106. The crawled liquefied object is absorbed by the liquefied object on the exposed surface of 102 layers of contacts. Consequently, a liquefied object remains on the portion which the contact layer 102 of the upper surface of the pillar-shaped section 101 exposed. The remaining liquefied object forms the lens configuration used as the original form of the laser outgoing radiation section 111 with surface tension.
[0058] According to the method of supplying a liquefied object to the pillar-shaped section 101 upper surface by the nozzle, the amount of drops at the viscosity of a liquefied object, the diameter of a nozzle, and the nose of cam of a nozzle etc. can be adjusted, or the thickness of the laser outgoing radiation section 111 can be easily controlled by surface treatment at the nose of cam of a nozzle etc. Moreover, since the supply method of the liquefied object by the nozzle cannot be easily influenced by the viscosity of a liquefied object, its range of an usable liquefied object is wide. Furthermore, since only a required place can supply a liquefied object certainly, there is no futility and a liquefied object does not adhere at an excessive place.
[0059] As a liquefied object of a resin, an ultraviolet-rays hardening type acrylic resin and an ultraviolet-rays hardening type epoxy resin can be mentioned, for example. The liquefied object of a polyimide precursor can be mentioned as a liquefied object of a precursor.
[0060] Since an ultraviolet-rays hardening type resin can be hardened only by UV irradiation, it does not have the worries about the damage by the heat to an element, exfoliation of the laser outgoing radiation section by the differential thermal expansion of the semiconductor layer and resin which are produced when it is made to heat-harden, etc.
[0061] An ultraviolet-rays hardening type resin consists of what contained at least one sort and the photopolymerization initiator among a prepolymer, oligomer, and the monomer.
[0062] As an example of an ultraviolet-rays hardening type acrylic resin, methacrylate, such as acrylate, such as epoxy acrylate, urethane acrylate, polyester acrylate, polyether acrylate, and SUPIRO acetal system acrylate, epoxy methacrylate, urethane methacrylate, polyester methacrylate, and polyether methacrylate, can be used as a prepolymer or oligomer, for example.
[0063] As a monomer, for example 2-ethylhexyl acrylate, 2-ethylhexyl methacrylate, 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, An N-vinyl-2-pyrrolidone, carbitol acrylate, tetrahydrofurfuryl acrylate, Single functionality monomers, such as isobornyl acrylate, dicyclopentenylacrylate, 1, and 3-butanediol acrylate, 1, 6-hexanediol diacrylate, 1, 6-hexanedioldimethacrylate, Neopentyl glycol acrylate, polyethylene-glycol diacrylate, 2 functionality monomers, such as pentaerythritol diacrylate, trimethylolpropane triacrylate, Polyfunctional monomers, such as trimethylolpropanetrimethacrylate, a pentaerythritol thoria chestnut rate, and dipentaerythritol hexaacrylate, are mentioned.
[0064] As a photopolymerization initiator, for example Acetophenones, such as a 2 and 2-dimethoxy-2-phenyl

acetophenone Butyl phenons, such as an alpha-hydroxy isobutyl phenon and a p-isopropyl-alpha-hydroxy isobutyl phenon A p-tert-butyl dichloro acetophenone, a p-tert-BUCHIRUTORI chloroacetophenone, Halogenation acetophenones, such as an alpha and alpha-dichloro-4-phenoxy acetophenone Benzophenones, such as benzophenone, N, and N-tetraethyl -4 and 4-diamino benzophenone Benzyls, such as a benzyl and a benzyl dimethyl ketal, a benzoin, Oximes, such as benzoins, such as benzoin alkyl ether, the 1-phenyl -1, and a 2-propane dione-2-(o-ethoxycarbonyl) oxime The radical generating compound of benzoin ether, such as xanthones, such as 2-methylthio xanthone and 2-chloro thioxan ton, the benzoin ether, and the isobutyl benzoin ether, and Michler's ketones can be mentioned. It has the advantage that the resin after hardening an ultraviolet-rays hardening type acrylic resin is highly transparent.

[0065] As a polyimide precursor, the long-chain alkyl ester of a polyamic acid and a polyamic acid etc. can be mentioned. The polyimide system resin which the polyimide precursor was made to heat-harden and was obtained has 80% or more of permeability in a light field, and since the refractive index is as high as 1.7-1.9, the big lens effect is acquired.

[0066] (6) Subsequently, the liquefied object of the upper surface of the pillar-shaped section 101 is stiffened, and field luminescence laser as shown in drawing 1 is completed. When a liquefied object is the above-mentioned ultraviolet-rays hardening type resin, it can be made to harden by irradiating ultraviolet rays.

[0067] Moreover, when the liquefied object of a polyimide precursor is used, it can be made to harden as a liquefied object by carrying out heating cure processing of the liquefied object of a polyimide precursor, causing an imide-ized reaction, and making polyimide resin generate. Although a curing temperature changes with kinds of precursor, viewpoints, such as prevention of the differential thermal expansion of the damage, the substrate, and polyimide resin by the heat to an element and alloying of an electrode, to about 150 degrees C are suitable for it. As heating time, the metal atom which constitutes an electrode is set as the grade which an anomalous diffusion does not produce inside a semiconductor layer.

[0068] Thus, ****** 110 is formed on the up electrode 106, the position in which it is going to form the laser outgoing radiation section 111 to which the up electrode 106 has carried out opening of the liquefied object can be supplied, and the laser outgoing radiation section 111 which functions as a micro lens only by hardening the liquefied object which remained on the contact layer 102 of the upper surface of the pillar-shaped section 101 can be formed by the self aryne. Thus, since the laser outgoing radiation section 111 can be formed by the self aryne, optical-axis doubling is unnecessary and the laser outgoing radiation section 111 without an optical-axis gap can be formed at a very easy process.

[0069] In the aforementioned process (5), although the supply method by the dispenser nozzle 117 was illustrated as a method of supplying a liquefied object to the portion which the contact layer 102 on the pillar-shaped section 101 exposed, as shown in drawing 7 , the method of injecting and supplying a liquefied object to the upper surface of the pillar-shaped section etc. is applicable using the ink-jet head 118. The method using the ink-jet head 118 can supply a liquefied object to the upper surface of the pillar-shaped section 101 in a short time, and has the advantage that productivity is high. In case the ink jet of the liquefied object is carried out, although the liquid viscosity of a liquefied object is an important element, it can also be adjusted to suitable liquid viscosity by adding a dilution solvent in a liquefied object.

[0070] Especially as a dilution solvent applicable to the liquefied object of an ultraviolet-rays hardening type resin, although not limited, propylene-glycol-monomethyl-ether acetate, the propylene-glycol monopropyl ether, methoxymethyl propionate, methoxy ethyl propionate, ethylcellosolve, ethylcellosolve acetate, ethyllactate, ethyl pill BINETO, a methyl amyl ketone, a cyclohexanone, a xylene, toluene, butyl acetate, etc. can be mentioned, it is independent, or two or more sorts can be mixed and used, for example.

[0071] As a dilution solvent applicable to the liquefied object of the precursor of a polyimide, a N-methyl-2-pyrrolidone can be mentioned, for example.

[0072] Furthermore, as a method of in addition to this supplying to the portion to which the contact layer 102 on the pillar-shaped section 101 exposed the liquefied object, the spin coat method, a dipping method, a spray coating method, the roll coat method, the bar coat method, etc. can be used suitably.

[0073] In the gestalt of the above-mentioned implementation, although the monomolecular film which consists of a thiol which has a functional group was described, ****** 110 is applicable as ****** 110 of this invention, if it is the monomolecular film which has the property which sticks not only to this compound but to the up electrode 106, and crawls the above-mentioned liquefied object. Moreover, ****** 110 is not restricted to a monomolecular film, and if it is the film which has the property which crawls a liquefied object, it will not be limited especially. Moreover, ****** 110 can exfoliate suitably if needed.

[0074] Moreover, although the above-mentioned manufacture process described the case where the front face of the metal layer which constitutes the up electrode 106 was a gold layer, if it sticks with ****** 111, it will not be limited

especially.
[0075]

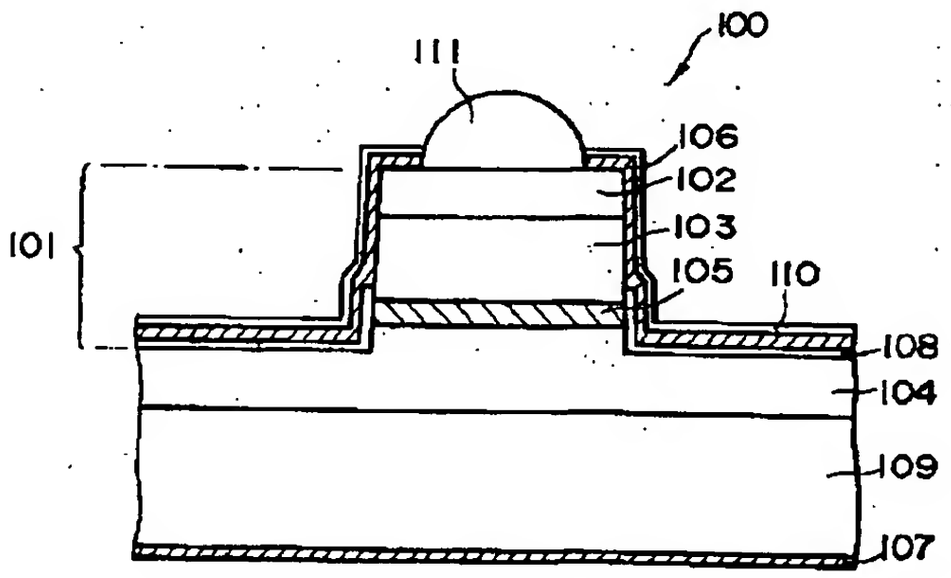
[Translation done.]

* NOTICES *

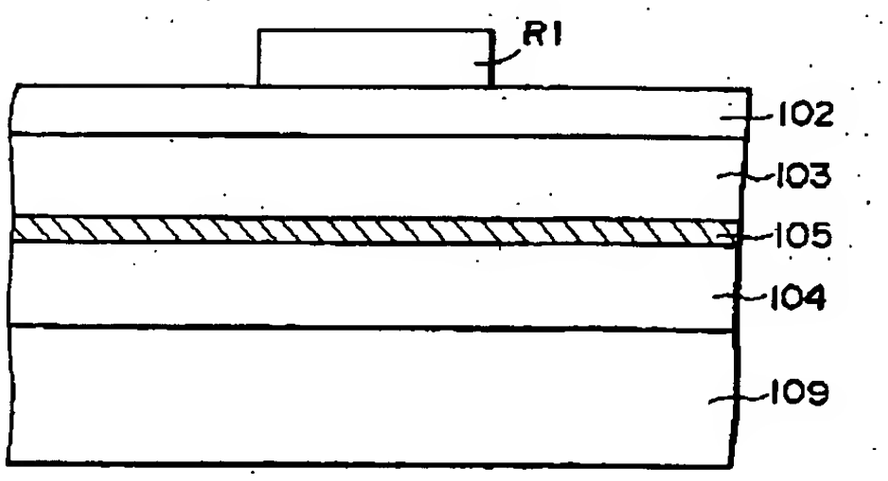
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

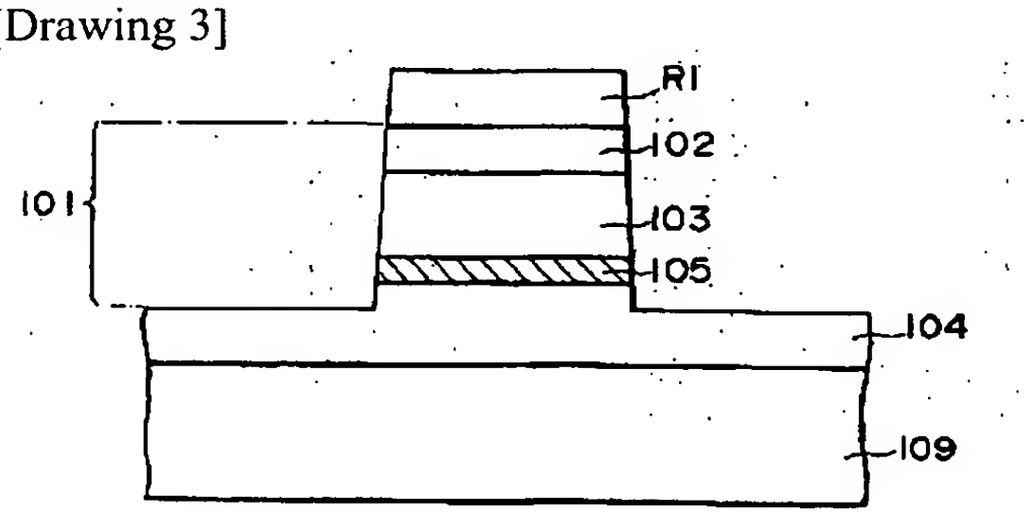
[Drawing 1]



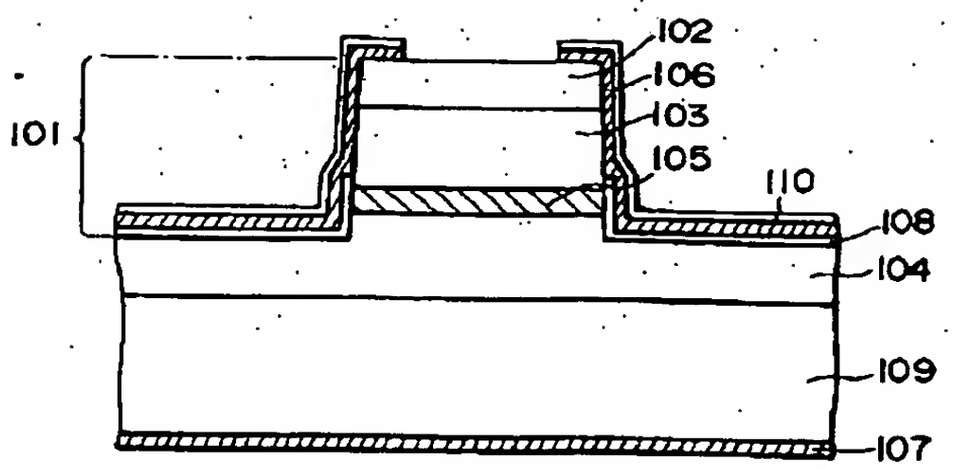
[Drawing 2]



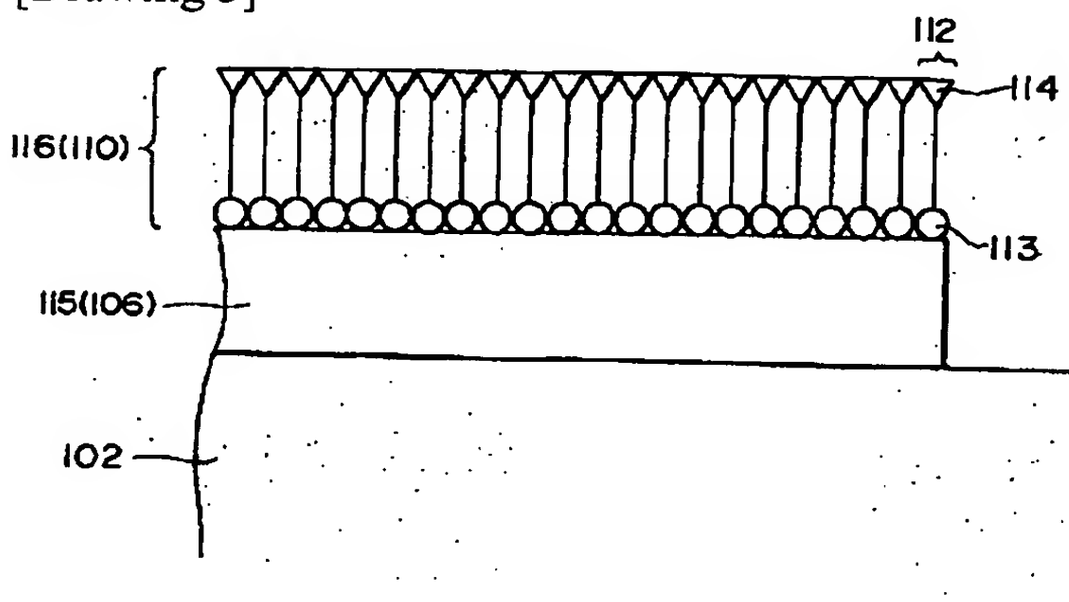
[Drawing 3]



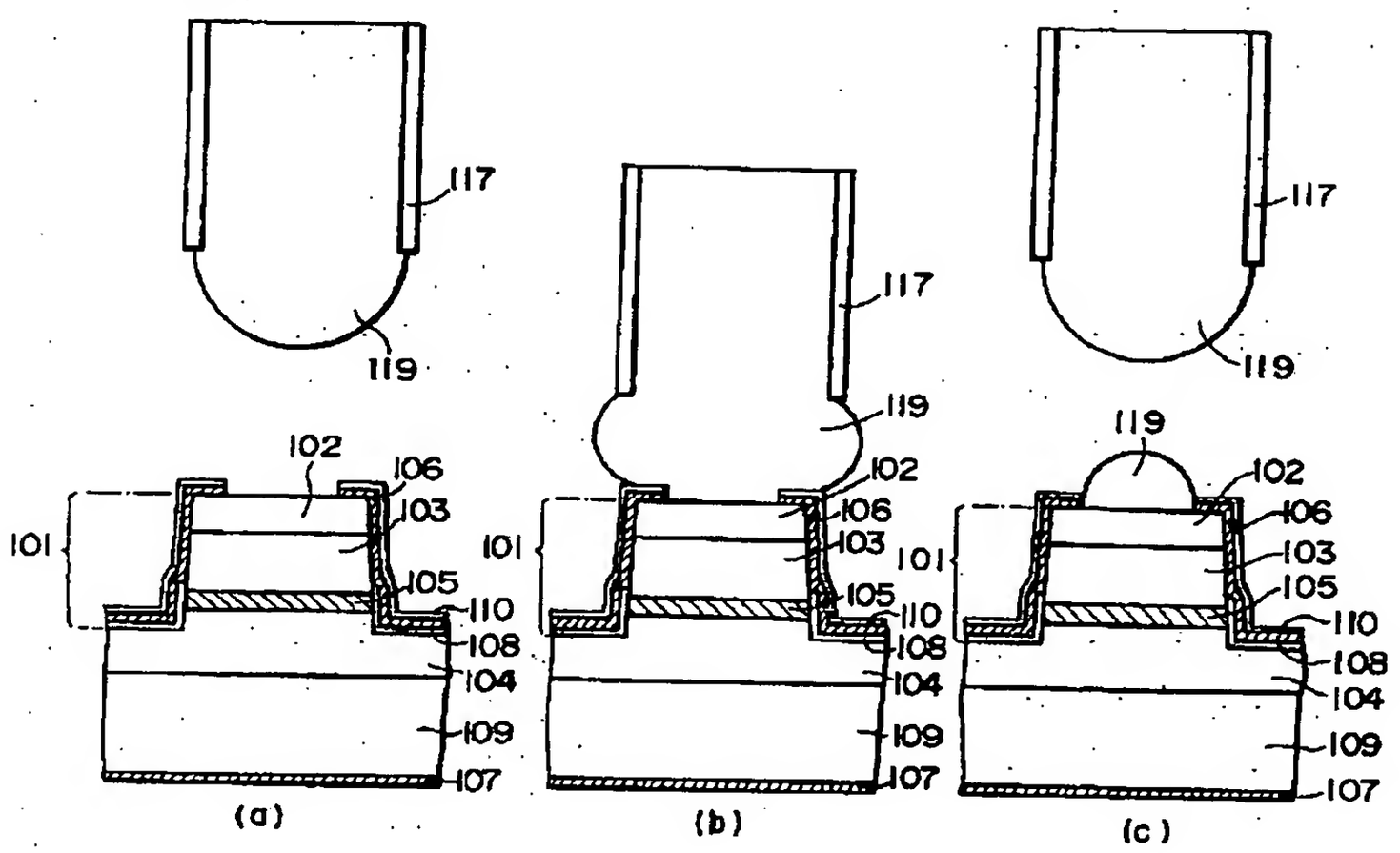
[Drawing 4]



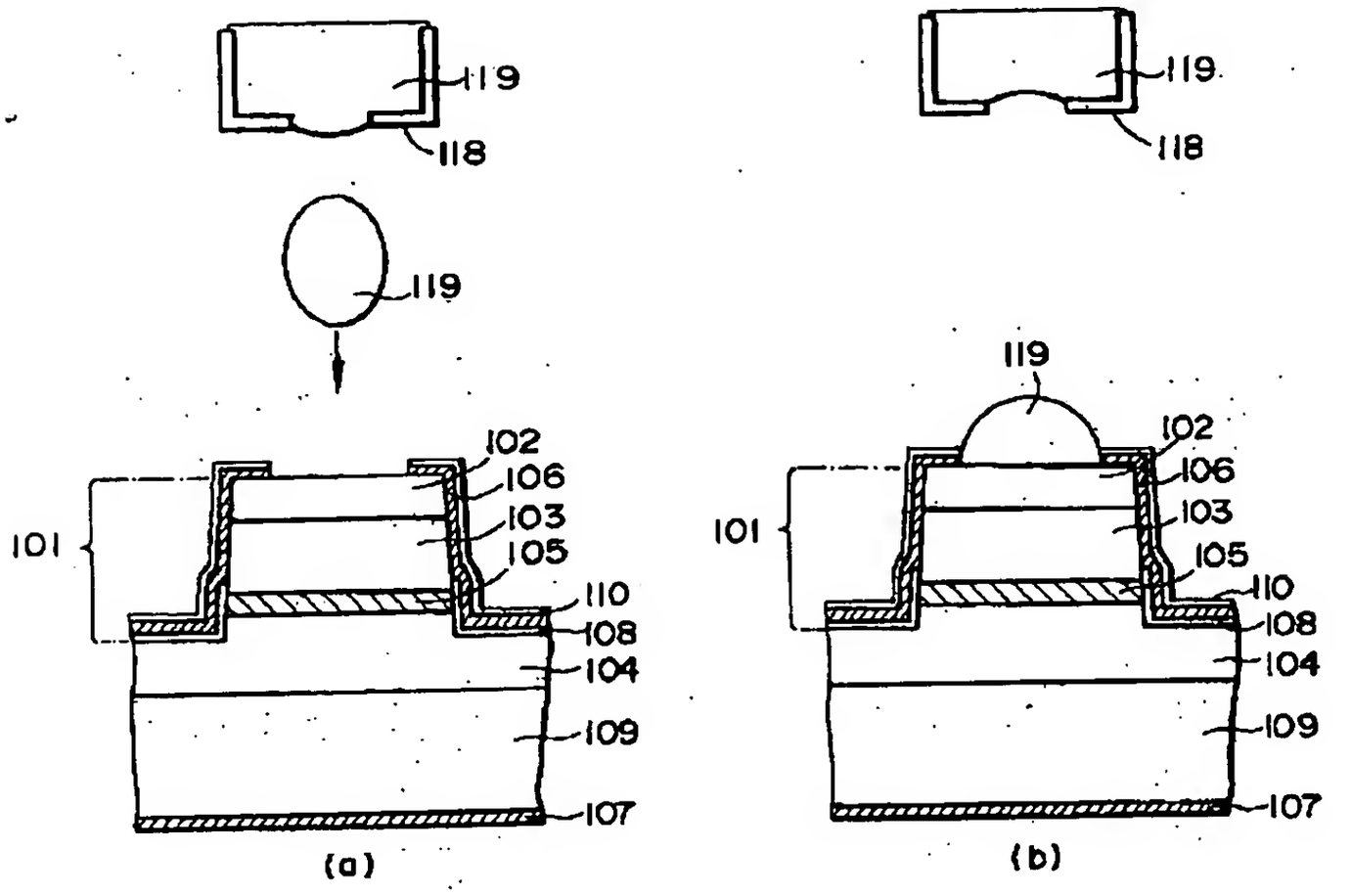
[Drawing 5]



[Drawing 6]



[Drawing 7]



[Translation done.]